

DEVICE AND METHOD FOR SAMPLE COLLECTION

FIELD OF THE INVENTION

The present invention relates to the field of sample testing. More specifically, the present invention concerns a collection device for use with a testing system such as a drug testing system.

BACKGROUND OF THE INVENTION

Testing for the presence of controlled substances has been widely used in government and industry for more than fifteen years. The traditional testing method involves collection of a urine sample from a donor, then sending the sample to a central laboratory for testing. A qualitative screening test is performed on the sample and the results of all of the tested samples are reported to the client, although negative results are often reported earlier than positive or inconclusive results. If a test is positive, it is repeated and the results are evaluated by a neutral third party. The target turn-around time for reporting negative results is 24 hours. There are many factors, however, such as sample transport time, lab staffing and daily volume fluctuations that can delay results. Approximately 85-90% of the samples tested for drugs screen negative. There is an industry need to obtain results from negative drug screens more quickly.

In response to this industry need, manufacturers have developed drug screening tests that can be evaluated at the collection sites. Many on-site test kits are designed to work on urine samples. The kit consists of one or more test strips packaged in a plastic housing. Typically, a technician applies a small amount of a urine sample (e.g. three drops) to a predetermined area on the test kit. The urine is then conveyed through the test strip, for example, by capillary action. Certain areas on the test strip are reactive when brought in contact with a specific drug analyte (e.g., Cocaine, THC, PCP). This reaction causes a change in the appearance of the test strip in that local area. The test strips also include a control area which indicates that the urine has been conveyed to all of the test areas and, thus, provides

an indication of when the results of the test may be read. After this area indicates a completed test, the technician reads the test strip and reports the result.

With on-site testing, negative drug screens can be reported to the client in a shorter time period than for laboratory tests. There is a growing interest in the use of on-site testing in the retail industry for pre-employment screening. While these test kits have gained widespread use, they are not without problems. First, the indicator for the drug analyte relies on a chemical reaction which may produce a continuum of results depending on the batch from which the test strip was selected, the age of the test strip and what the person being tested ate or drank before being tested. These variations in the indicators may result in one technician reading a result as a negative while another tester would read the same result as being inconclusive. Because all inconclusive tests must be followed up with a laboratory test and that test evaluated by an independent third party, it would be beneficial if a test could be devised which did not rely on human judgement or on the training or experience of the technician administering the test.

Finally, many test kits require the technician to measure a predetermined amount of urine and apply it to the test kit. This may undesirably bring the technician into contact with the urine.

SUMMARY OF THE INVENTION

According to one aspect, the present invention is embodied in a collection cup for a drug testing system including a central volume and a trough, exterior to the central volume. The trough is configured with a pour spout such that, as fluid is poured from the cup, a controlled volume remains in the trough. The trough is configured to receive an on-site test kit and to apply the controlled volume of the fluid to test strips within the on-site test kit.

According to another aspect of the invention, the trough also includes one or more apertures in the wall between the trough and the central volume which allow excess fluid to flow back into the cup when the cup is placed upright after pouring and when the test kit is inserted into the trough.

According to another aspect of the invention, the central volume of the collection cup defines an asymmetric cross section which is configured to mate with a similarly shaped asymmetric holder such that the cup is in a predetermined orientation when it is placed in the holder.

5 According to yet another aspect of the invention, a collection device is provided with a central chamber defining an open volume and a trough defining an open volume, smaller than the open volume of the central chamber, wherein the trough is positioned adjacent the central chamber. The collection device also includes an interior pour spout positioned for flow of a sample from the central
10 chamber into the trough. An exterior pour spout is positioned for sample flow from the trough and out from the device. The central chamber is adapted to hold a sample, and the trough is adapted to receive a controlled volume of the sample as the sample is poured from the device through the interior pour spout and the exterior pour spout. The trough is configured to receive a portion of a test kit for
15 submersion in the controlled volume of the sample. The collection device can include a collection cup and a lid. The trough can be formed in the collection cup or in the lid.

20 According to still another aspect of the invention, a method is provided for testing a using a test kit. A collection device is provided as described in the previous paragraph. A sample is introduced into the central chamber, and the sample is poured from the collection device through the interior and exterior pour spouts, thereby introducing a controlled volume of the sample into the trough. The test kit is inserted into the trough, thereby submerging a portion of the test kit in the controlled volume of the sample.

25 It is to be understood that both the foregoing general description and the following detailed description are exemplary, but not restrictive, of the invention.

BRIEF DESCRIPTION OF THE DRAWING

The invention is best understood from the following detailed description when read in connection with the accompanying drawing. Included in the drawing are the following Figures:

Figure 1 is a top plan view of a test station showing some of the components of the on-site drug testing system;

Figure 2 is a cut-away side plan view of an automatic reader and the test cup taken along 2-2 shown in Figure 1;

Figure 3 is a flowchart diagram which presents an overview of the method for on-site drug testing; and

Figure 4 is a front plan view of an exemplary test kit suitable for use with the present invention.

Figure 5A is a top-plan view of a collection cup suitable for use in the drug testing system shown in Figure 1.

Figure 5B is a side plan view of a test kit docked with the collection cup shown in Figure 5A.

Figure 5C is a front plan view of the combined test kit and collection kit shown in Figure 5B.

Figure 5D is a rear perspective view of the upper portion of the collection cup shown in Figure 5A.

Figure 6A is a top plan view of another embodiment of a collection device according to this invention.

Figure 6B is a side view of the collection device illustrated in Figure 6A.

Figure 7A is a side view of another embodiment of a test kit suitable for use in the drug testing system according to this invention.

Figure 7B is a top plan view of an assembly of the collection device illustrated in Figure 6A and the test kit illustrated in Figure 7A.

5 Figure 7C is a side view of the assembly illustrated in Figure 7B.

Figure 8 is a top plan view of yet another embodiment of a collection device according to this invention.

Figure 9 is a cross-sectional side view of the collection device illustrated in Figure 8.

10 Figure 10 is another cross-sectional side view of the collection cup illustrated in Figure 8.

Figure 11 is a partial cross-sectional side view of an assembly of another embodiment of a test kit suitable for use in the drug testing system according to this invention together with the collection device illustrated in Figure 10.

Figure 12 is another cross-sectional side view of the assembly illustrated in Figure 11.

DETAILED DESCRIPTION OF THE INVENTION

20 Although the present invention is described in terms of a test kit which tests urine samples, it is contemplated that it may be extended to cover the automatic evaluation and reporting of test results based on other samples (e.g. saliva or other aspects of a person which may indicate possible drug use such as a donor's sweat, hair or breath). Other examples of samples that can be collected and tested

according to this invention include serum, plasma, lymph fluid, spinal fluid, amniotic fluid, feces, tears, combinations of such samples, or such samples alone or in combination with diluents.

An exemplary on-site drug testing system according to the present invention includes the following components:

- A network of collection sites.
- Integrated consumables -- the on-site test kit and the urine collection container that work together. Each of the consumables is given a bar-code which is associated with the person being tested.
- An automated test strip reader that eliminates the subjective nature of manual reads and transposition errors when recording results.
- A computer workstation which allows a minimally skilled technician to automatically generate test orders, record the chain of custody for the samples and transmit the on-site results to a central database.

Figure 1 shows an exemplary collection site, including several components for the on-site drug testing system. The arrangement on table 95 includes, an automated reader platform 60, a computer workstation 50, which includes a CPU, a modem, a monitor and a keyboard 90, an automated signature reader 70, a bar code scanning wand 40 and a plurality of collection devices or cups 10. In the exemplary embodiment of the invention, the collection cups are formed from a plastic such as polypropylene although it is contemplated that they may be formed from other materials which exhibit low absorption of the drug residues for which the tests are being conducted. Referring to Figure 1, one of the collection cups 10 is placed onto the reader 60. The collection cup 10 contains one of the test kits 20. Keyboard 90 is used by the technician to enter appropriate information on

the person being tested. The wand 40 is used to scan the bar code or codes of the test kit, sample vial (not shown) and the collection cup to associate a particular sample and test result with a particular individual.

Figure 2 shows a cut away side plan view of the automated reader platform 60, taken along lines 2-2 shown in Figure 1. The automated reader platform 60 includes an automated reader 55, a light source 35, a collection cup 10, and a test kit 20. The automated reader 55 includes an imager (camera) 45 and interface circuitry (not shown) which provides operational power to the camera 45 and through which images captured by the camera may be transferred to a video capture card (not shown) in the computer workstation 50. As described below, the workstation 50 analyzes images of the test kit 20 to automatically determine the results of the test. In the exemplary embodiment of the invention, the raw data provided by the reader 55 is automatically stored locally in the workstation 50 and also sent, along with the results of the test, to the central computer (not shown) via the modem (not shown) or other communicating device.

In the exemplary embodiment of the invention, the automated reader 55 may be a BC460 CCD solid-state black and white board camera, available from Ultrak, Carrollton, Texas. Workstation 50 may be, for example, an IBM compatible personal computer running Windows NT with 64 MB of RAM and an image capture board (not shown) that is compatible with the automated reader 55. The modem may, for example, be a conventional 56K modem. Alternatively, the workstation 50 may include a network card through which it connects to a local server which is, in turn, connected to the central computer via a dial-up connection, dedicated wide-area network or a secure Internet connection.

The collection cup 10 used with the present invention includes a trough 42 adjacent to the pour spout 43 of the cup. After the person being tested has filled the cup, the technician pours a portion of the sample into a separate vial (not shown) which, as described below, may be used to send the sample to a laboratory for further testing. In one embodiment, the size of the vial is 45 ml. As the technician pours the urine from the cup 10 into the vial, urine flows into the trough 42 until the trough is filled. The upper portion of the trough includes an

engagement mechanism 22 which locks the test kit 20 in place in a fixed position in the trough. An exemplary test kit is shown in Figure 4. As shown in Figure 4, the test kit includes one or more openings 305 through which the test strips 306 and 307 may be wetted. The engagement mechanism 22 holds the test kit in the trough 42 such that the opening 305 is immersed in urine. In the exemplary embodiment of the invention, the engagement mechanism may be, for example, an opening in the trough having an area slightly smaller than the cross-section of the test kit 20. As the test kit 20 is inserted into the opening, the wall of the trough toward the interior of the cup bends to apply pressure to the back surface of the test kit. The engagement mechanism 22 does not, however, block or otherwise interfere with the opening 305.

In addition, the automated reader platform 60 includes a collection cup holder 30 which is used to place the docked components in a fixed position in the reader platform 60 so that the test kit 20 is in proper position to be read by the camera 45. In the exemplary embodiment of the invention, the cup holder 30 and cup 10 each includes structural features (not shown) which ensure that the cup 10 and the test kit 20 may be inserted only in one location and orientation for imaging by the camera 45.

In the exemplary embodiment of the invention, the test kit may, for example, be a Syva® RapidTest d.a.u.™ test kit which is available from Behring Diagnostics, Inc. or any similar on-site test kit which conforms to the engaging mechanism 22 of the collection cup 10.

In a typical drug screen, the donor brings an authorization form (not shown) containing a client (e.g. employer) bar-code identifier. The technician wands the client bar-code and the workstation 50 assigns a requisition number to the donor. The combination of the client bar-code and a bar-code for the requisition number form a unique identifier for the donor. The workstation 50 then prints out a set of bar-code labels to be applied to all of the consumables in order to associate the consumables uniquely with the donor. Additionally, in response to the wand of the client bar-code, the workstation displays an electronic form on the monitor of the workstation 50. This form includes fields for information about the person

being tested, such as name, address, age and other identifying information. After entering this information, the technician hands the collection cup to the person being tested.

When the person returns with the sample, the technician checks a temperature strip 32 (shown in Figure 2) on the lower portion of the collection cup 10. In the exemplary embodiment of the invention, the temperature strip 32 includes a series of temperature-sensitive regions (not shown), each of which changes color at a different temperature. The technician may wait until the donor returns with the sample or he may process other donors and, when each donor returns with a sample, wand the bar-code on the cup to bring-up that donor's order form. In either method, the technician then enters the temperature information in a field of the order form.

The technician then pours a portion of the sample from the cup 10 into the collection vial (not shown) thereby filling the trough 42. Next, the technician docks the test kit 20 into the engagement mechanism 22 of the trough 42, immersing the opening 305 of the test kit in the urine sample. The technician then places the integrated cup 10 and test kit 20 into the collection cup holder 30 of the automated reader platform 60, placing the cup 10 and test kit 20 into the reader platform 60 in a fixed position. In the exemplary embodiment of the invention, the cup holder 30 is a drawer which extends from the side of the reader 55 so that a technician may place an integrated cup 10 and test kit 20 into the cup holder 30 and cause the cup holder to be retracted into the reader. In its retracted position, the cup holder 30 holds the test kit in proper orientation for imaging by the automated reader 55.

The technician then signals the workstation 50 through the keyboard 90 that the sample has been inserted. While the automated reader 55 is obtaining the test results, the technician seals the vial and completes the chain of custody documents. The donor is then dismissed.

In response to this signal to begin the test, the workstation 50 obtains and stores an image of the test kit 20 using the reader 55 and the image capture board. The workstation analyzes this first image to ensure that the test kit has been

properly integrated into the collection cup 10 and that the collection cup 10 has been properly placed into the cup holder 30. The workstation 50 may, for example, perform this function by checking several of the values at several picture element (pixel)-positions, corresponding, for example to specific printed and blank areas on the test kit, for predetermined pixel values. If these values are found, then the test kit is properly aligned. If pixels are not as expected, then the workstation 50 displays a message asking the technician to check the positioning of the test kit 20 in the cup 10 and the positioning of the cup 10 in the platform 60 and to signal the workstation when they have been repositioned. In response to this signal, the workstation 60 repeats the test. After a predetermined number of failures, the workstation signals that the test is inconclusive and instructs the technician to send the vial to the laboratory for further testing. The workstation also sends the identification information on the order form to the central computer so that, at the laboratory, the vial can be associated with the person being tested.

As an alternative to testing specified pixel positions and signaling the technician to re-seat the collection cup, the workstation 50 may correlate the image of obtained from the docked test kit 20 to several different images, each representing a possible displacement of the test kit from a reference position. The image having the highest correlation then defines displacement values relative to the reference position, which are used to obtain data from the image for analysis.

Once the cup is properly seated, the workstation 50 may periodically signal the reader 55 to capture images of the test kit. Figure 4 shows an exemplary image that may be obtained by the reader 55. This image includes a bar-code 310 which identifies the image of the test kit with a particular individual, and two test strips 306 and 307. Test strip 306 corresponds to an area 301 of the test kit which is examined for the presence of controlled substances such as PCP 370, THC 360, cocaine 350, opiates 340 and methamphetamines 330. Test strip 302 corresponds to an area of the test kit which is examined for the presence of adulterants, that may affect the validity of the test. In the exemplary embodiment of the invention, the adulterants which are identified include bleach 375, electrolyte beverages 380, soft-drinks 390 and nitrites. These controlled substances and adulterants are merely

exemplary and do not exclude the testing for other controlled substances and adulterants.

5 The exemplary test strips also includes control regions 320, labeled with a "C," which change color in the presence of any water-based liquid. These regions are positioned farthest from the opening 305 and indicate that the sufficient urine has been absorbed by the test strips 306 and 307 to provide valid results. In the exemplary embodiment of the invention, the various indicating regions on the test strips 306 and 307 are horizontal bars which are imaged by the reader 55 to have a thickness or width of approximately 10 pixels and a length of approximately
10 100 pixels.

As each of the sequential images is provided by the reader 55, the workstation 60 checks the intensity of predetermined pixel positions corresponding to the control regions 320 to determine when the other regions may be analyzed for controlled substances and adulterants. When an image is captured having a
15 sufficient intensity in the control regions 320, the workstation then analyzes pixel positions in the image which correspond to test regions 330, 340, 350, 360 and 370 for each of the controlled substances and to test regions 375, 380, 390 and 395 which correspond to each of the adulterants. In the exemplary embodiment of the invention, each test region may, for example, be analyzed by averaging intensity
20 values from a predetermined number (e.g. 50) of pixel positions which are positioned near the central portion of the test region. The averaged intensity values obtained by the workstation 60 are then compared to reference values to determine if the test is negative, positive or indeterminate.

25 In the exemplary embodiment of the invention, a dark-colored bar appears in the region if the test is negative and no bar appears if the test is positive. The intensity of the pixels that are sampled from the bars corresponds to the luminance level of the pixels. Thus a dark pixel has a relatively low intensity value while a bright pixel has a relatively high intensity value.

30 A common problem in analyzing on-site drug testing kits occurs when a faint bar appears in any of the regions. The technician must decide whether the

faint bar represents a negative, positive or inconclusive result. Different technicians may classify bars with the same intensity differently. The present invention obviates this problem by objectively classifying pixel intensities that are determined under controlled conditions. The exemplary workstation 60 classifies the averaged pixel values as representing a positive, negative or inconclusive result based on whether they are in first, second or third ranges of possible intensity values.

Figure 3 shows an overview of the method for on-site drug testing. First in step 210 the donor receives a collection kit and a test kit, which is identified with a bar code. Next, in step 220 the technician wands the bar-code to bring up the electronic order form. Also in step 220, the donor and the technician enter identifying and other data into the electronic order entry system. The donor then takes the collection cup 10 and voids. When, at step 230, the technician receives the sample, he checks the temperature sensor 32 on the cup 10 to determine it is consistent with the amount of time since the donor voided. Also, at step 230, the technician pours a portion of the sample into a 45ml vial (not shown), thereby filling the trough 42 of the collection cup 10.

If, as step 230, the temperature of the sample is out of range, the technician may request another sample, in which case, the process branches to step 230, or he may accept the sample and proceed to step 240. At step 240, using keyboard 90, the technician then determines the volume of the sample and enters the volume and temperature data into the donor's order entry form. In step 240 the printer (not shown) which is coupled to the workstation 50 prints out a hard-copy of the custody documents. The donor and the technician then sign the chain of custody documents, including the security seal that is placed over the 45ml vial and the donor is excused.

In the exemplary embodiment of the invention, the custody documents may be placed on the automated signature reader 70 before they are signed. As the documents are signed, the signatures of the donor and the technician are collected electronically and associated with the order form which is transmitted to the central computer. The documents and the vial are placed in a sealed bag for delivery to the laboratory if necessary, as described below. Because the signatures are captured

electronically, they can be matched to the signatures on the chain of custody documents by the central laboratory or by the independent third party.

Continuing with Figure 3, in step 250 the technician docks the test kit 20 in the engaging mechanism 22 of the trough 42. Once the test kit 20 is docked with the collection cup 10, the urine from the trough will flow into the test kit 20 via capillary action or other similar action. Next, in step 260, the technician placed the integrated test kit 20 and collection cup 10 onto the automated reader platform 60. Additionally, in step 260, the technician engages a START button on the order form to notify the workstation 60 that the collection cup has been placed in the reader. At step 255, the workstation 50 obtains an image of the test kit, as described above, to determine if the test kit 20 is seated properly in the collection cup 10 and if the collection cup is seated properly in the reader platform 60. If the either of these devices is not seated properly then, at step 257, the workstation 50 asks the technician to check the docking of the test kit 20 in the collection cup 10 and the placement of the collection cup 10 in the reader platform 60. The technician signals the workstation that the collection cup and test kit are properly aligned by activating a button on the order form.

Once the workstation 50 determines that it can obtain an acceptable image of the test kit 20, it may start an internal timer (not shown) to determine when to read the sample. In the exemplary embodiment of the invention, the test kit should provide an acceptable image two minutes after the opening 305 is immersed in the sample. At step 270, when the timer indicates that a valid sample should be available, the workstation 50 captures an image of the test kit and analyzes the image, as described above, to determine the presence of any of the enumerated controlled substances and adulterants.

As an alternative to setting the timer and reading the test kit when the timer expires, the workstation 50 may capture a time sequence of images, recording the results of each sample internally, as described above, until the control regions 320 indicate that the data displayed by the test kit should be valid. In this alternative embodiment of the invention, if the workstation 50 does not attain a valid reading within 10 minutes it declares the test inconclusive.

Once the workstation 50 determines that the reading from the test kit 20 is valid, it analyzes each of the regions on each of the test strips, as described above, and records the results. At step 280, the workstation 50 sends the completed order form and the test results to the central computer, using the modem. At step 5 290, the workstation determines if the test was positive, indeterminate or, as described below, if the sample is a random sample that is to be laboratory tested in order to verify the proper operation of the collection site. If any of these conditions occurs, the technician, in step 295, is instructed to send the 45 ml vial in a transport bag with the requisition to the central laboratory. The central laboratory then 10 performs confirmatory testing and reports the results through channels that may not include the technician, for example, directly to the personnel department of the company performing the testing.

In addition, it is contemplated that the workstation 50 may not inform the technician of the results of the test and/or may not inform the technician of 15 which samples need to be sent to the central laboratory. In this alternative embodiment, the technician would store all vials as they are produced and, only at the end of a particular batch of tests or at the end of a day of testing, would the workstation generate a list of samples to be sent to the central laboratory.

On each of the test strips 306 and 307 of the test kit 20, the indicating bar for each specific test may vary in thickness or width and intensity depending on the concentration of the drug and the presence of adulterants in the urine sample. The advantage of using the automated reader 55 and the workstation 50 to 20 automatically read and interpret the results of the test, is that the subjectivity of the reading is eliminated, ensuring that all readings are done quickly, uniformly and fairly. The on-site drug test system further ensures fairness by randomly sending 25 blind samples with known results to the central laboratory for confirmatory testing. In the exemplary embodiment of the invention, every N^{th} sample (e.g. $N = 40$) is sent to the central laboratory for confirmatory testing regardless of whether the interpreted results obtained by the automated reader 55 and workstation 50 were 30 positive or negative.

The on-site drug test system further ensures integrity by periodically re-calibrating the system (e.g. once each day) and by re-calibrating the system for each different batch of test kits. These re-calibration operations may be done at the request of the technician or the workstation 50 may prompt the technician when re-calibration is needed. For example, the workstation may request daily re-calibration before the first test is conducted on any day. This re-calibration may be performed, for example, by placing one or more calibration fixtures, each including an image of a test kit with known intensity levels in the various controlled substance and adulterants, into the platform 60 and signaling the workstation 50 to calibrate itself based on the calibration fixtures. In the exemplary embodiment of the invention, each calibration fixture may contain an identifying code which is read by the automated reader 55 and the workstation 50. Alternatively, the technician may be prompted to enter an identifying code for the fixture.

The on-site drug test system may be re-calibrated for different batches of test kits by having the technician manually enter a re-calibration request when a new batch of test kits is opened or by having the workstation 50 scan for a batch code (not shown) on the image of the test kit as a part of its reading and analysis process. In this alternative embodiment, the workstation may store calibration constants for each of a plurality of test-kit batches or it may prompt the technician to insert one or more test kits from the new batch into respective test solutions of known composition. If the latter method is used, the workstation 50 may analyze the images to generate and store a set of calibration factors for the new batch of test kits. These calibration factors may then be used to normalize any test results obtained using test kits from the identified batch.

Referring back to Figure 3, in step 280 both the raw data and the interpreted results may be automatically recorded and transmitted to the central computer. The recorded raw data may include, for example, the actual image data for the first valid image of the bars on the test strips; the number of pixels in each bar and the average intensity of each bar; or a losslessly compressed image, (e.g., LWZ) of the bars or of the entire test kit. This raw data may be passed to the central computer for every test or for just the random calibration tests. In addition, the raw image data may be stored locally and used, for example, to re-run a test

after a calibration step, when, for example, the test was first run with a test kit from a new batch.

Another embodiment of the on-site drug testing system utilizes the automated reader 55 and the workstation 50 to automatically read and record additional information about the sample. The additional information may include, for example, the temperature from the temperature strip 32, the identifying bar code, the volume of the sample and batch number of the test kit.

The maintenance and calibration of the lab equipment is an important part of the drug testing system. Annual preventive maintenance is performed to ensure that all equipment is functioning properly and to prevent equipment malfunctions. Additionally, the reader 50 is calibrated daily to compensate for the sensitivity of the imager 45 and the variations in the intensity in the light source 35. The calibration is performed by using a test kit 20 and test solution which produces image data having a known intensity. The result of the calibration process can be affected by the distance between the imager 45 of the Reader 50 and the collection cup 10 and by the intensity of the lighting from the light source 35. Consequently, calibration should also be performed whenever a light in the light source 35 is changed and whenever the lot number of the test kit 20 changes.

Various forms of collection devices are contemplated for use with the testing system. Referring generally to the figures, the collection device such as collection device 10 or collection device 600 preferably includes a central chamber defining an open volume. A trough such as trough 42 or trough 608 or reservoir 616 is provided in the collection device to define an open volume, smaller than the open volume of the central chamber. The trough is positioned adjacent said central chamber. An interior pour spout such as spout 422 or slot 610 is positioned for flow of a sample from the central chamber into the trough. An exterior pour spout such as spout 410 or 618 is positioned for flow of sample from the trough and out from the device. The central chamber is adapted to hold a sample, and the trough is adapted to receive a controlled volume of the sample as the sample is poured from the device through the interior pour spout and the exterior pour spout. The trough

is configured to receive a portion of a test kit such as test kit 20 or test kit 632 for submersion in the controlled volume of the sample.

Figures 5A through 5C illustrate an exemplary collection device or cup 10 having an engagement mechanism 22 and trough 42 which are suitable for use with the present invention. Figure 5A is a top plan view of the collection cup 10. The exemplary collection cup has a "D" shaped cross-section except for the portion which includes the trough 42 and pour spout 410. The cup holder 30 of the automated reader platform 60 includes a "D" shaped opening, which matches the cross-section of the bottom of the collection cup. Thus, the cup holder 30 holds the cup 10 in a fixed position such that the docked test kit 20 is held in a predetermined orientation and position within the automated reader platform 60.

The test kit 20 is inserted into the trough 42 and is held in place by the engagement mechanism 22. In the exemplary embodiment, the engagement mechanism 22 includes two locating fingers 414 which extend from the sides of the trough 42. The distance between the back surfaces of the locating fingers 414 and the back of the trough 42 is approximately the same as the thickness of the test kit 20. Thus, when the test kit 20 is inserted in the trough 42, it is held in place by the fingers 414.

Figure 5B is a side-plan view of the collection cup 10 with the test kit 20 in place. The trough 42 shown in Figures 5A through 5D extends down only a small portion of the height of the collection cup 10. Thus, the trough 42 shown in these figures is relatively shallow compared to the trough shown in Figure 2. As shown in Figure 5B, the test kit 20 is held in the trough 42 so that the back surface of the test kit engages the back surface of the trough and the sides of the front surface of the test kit engage the two locating fingers 414. When the test kit 20 is inserted in the engagement mechanism, only a small portion of the trough 42, between the fingers 414, holds urine. As shown Figure 5C, this small portion of the trough is immediately in front of the openings 305 of the test kit 20.

The volume of the trough 42 is designed such that, when the test kit 20 is inserted, the amount of fluid in trough 42 is sufficient to wet the test strips 306

and 307 but does not detrimentally flood the test strips. In one embodiment, the volume of the trough is about 1000 to about 2000 microliters, more preferably about 1100 to about 1500 microliters, depending on the kit. This volume is exemplary and may change, for example, if a different test kit is used for the test kit 20. The parameters for designing the amount of urine in the trough include: (a) the number of apertures 420; (b) the size of each aperture; and (c) the volume of the trough. In one embodiment, when the test kit is inserted in the trough, the apertures are designed (e.g. number and size) to allow any excess urine to flow back into the cup 10 at a sufficient rate so as to prevent splashing of the urine. It is desirable to control the amount of urine applied to the test kit in order to produce a predictable test result. Figure 5D is a perspective rear-view of the collection cup 10 which illustrates features of the cup that enable it to hold the controlled amount of urine.

In the exemplary illustrations, the rear wall of the trough 42 includes two apertures 420 and a notch 422. As described above, when the technician pours the urine from the collection cup 10 into the vial, the urine flows into the trough 42 through the notch 422 and the apertures 420. As it fills the trough, the urine then flows through the pour spout 410 and into the vial. When the cup 10 is again placed upright, excess urine in the trough flows back into the cup through the apertures 420 to yield a controlled amount of urine. In one embodiment, when the test kit 20 is inserted into the trough 42, the test kit blocks the apertures 420, causing the urine in the trough to flow in front of the test kit 20 where it is absorbed by the test strips 306 and 307 through the openings 305 in the front of the test kit 20. In another embodiment, when the test kit 20 is inserted into the trough, the test kit displaces an excess amount of and causes the urine to flow through the apertures 420 back into the cup 10. Only a measured amount of urine remains in the trough 42 and this is largely absorbed by the test strips 306 and 307 of the test kit 20.

The exemplary collection cup 10 is designed to minimize the technician's potential contact with the urine in the cup. The operation of pouring the urine from the cup into the vial causes a measured amount of urine to flow into the trough 42.

For the purposes of the present invention, the terms "notch" and "spout" are interchangeable and mean a guide through which a liquid is discharged.

Referring now to Figs. 6A and 6B, another embodiment of a collection device, generally designated by the numeral "500", will now be described.

5 Collection device 500, like the prior embodiments, provides a trough 542 in a cup-shaped container. An engagement mechanism 522 is provided in conjunction with the trough 542. The engagement mechanism 522 of collection device 500 differs from that in the embodiment shown in Fig. 5A in that two (2) pairs of locating
10 fingers 514 are provided to extend inwardly from the side walls of trough 542. These locating fingers 514 engage a test kit at a location that is spaced slightly away from the external wall 515 of the cup's body. The additional fingers 514 allow the sample to flow around the test kit when the test kit is inserted into the trough, thereby avoiding spillage. This feature is especially useful for use with test kits configured like test kit 20 (Fig. 5).

15 Like the previous embodiments, collection device 500 includes a notch 512 to facilitate the flow of sample from the cup's central chamber into the trough 542 as well as a notch 512 to permit the flow of sample from the trough 542 outwardly through an external pour spout 510 as the sample is poured into a separate vial, for example.

20 Referring now to Figs. 7A-7C, an assembly of a test kit and collection device 500 will now be described. Referring specifically to Fig. 7A, an embodiment of test kit 520 has exposed portions of test strips 550 that extend outwardly (downwardly in Fig. 7A) from the housing of the test kit. Test kit 520 also includes a portion 552 of reduced width adjacent the exposed test strip ends.
25 Reduced width portion 552 establishes an edge 554 between portions 552 and the remainder of the body of test kit 520.

30 Test kit 520 is shown mounted in collection device 500 in Figs. 7B and 7C. As is illustrated in Fig. 7B, test kit 520 is engaged between the locating fingers 514 of trough 542, thereby defining a space between the test kit 520 and the exterior wall 515 of the cup's body. As is illustrated in Fig. 7C, the edge 554 of test kit 520 provides a stop surface that contacts the top edge of collection device

500, thereby controlling the relative position (elevation) of the bottom edge of test strips 550 with respect to the bottom surface of trough 542.

Referring now to Figs. 8-10, yet another embodiment of a collection device according to this invention will now be described. This collection device, generally designated by the numeral "600", is similar to the previous embodiments in that it provides a trough that is configured to receive a portion of a test kit for submersion in a controlled volume of sample stored in the trough. This embodiment of collection device 600 differs from the previous embodiments only in that the trough is provided as part of a lid of the container as opposed to the container's cup. In all other respects, including the manner of its use, collection device 600 corresponds to the other collection devices described herein.

As is illustrated in Fig. 8, collection device 600 includes a docking lid 602 and a collection cup 604. The docking lid 602 has a planar lid surface 606 that at least partially encloses the chamber defined by collection cup 604. Docking lid 602 includes a trough 608 which is configured to retain a controlled volume of sample and is also configured to receive at least a portion of a test kit for wetting of test strips mounted within the test kit.

More specifically, referring to Figs. 8-10 generally, the trough 608 of docking lid 602 includes a rectangular slot 610 formed in a ramp portion 626 of the trough 608. Slot 610 facilitates the flow of sample into trough 608 from the collection cup 604 as sample is poured from within collection cup 604 into a separate vial through a pour spout 618.

Trough 608 also includes a pair of spaced apertures 612 that are provided to facilitate the return flow of sample from trough 608 back into collection cup 604 when collection device 600 is returned to an upright position (as shown in Fig. 9). Trough 608 also includes a pair of side channels 614 that are positioned and sized to accommodate a portion of a test kit, as will be described in further detail with reference to Figs. 11 and 12.

Trough 608 also includes a base channel 616 that is provided to contain the controlled volume of sample. Accordingly, channel 616 is the reservoir

that holds the sample, and trough 608 is primarily provided for runoff of the sample during pouring of the sample from the device. More specifically, base channel 616 extends downwardly from a base surface 624 of trough 608 in order to provide a reservoir for sample. The volume of base channel 616 substantially corresponds to the volume of sample contained within trough 608 when collection device 600 is in the upright position of Fig. 9. Specifically, it will be understood that, when the collection device 600 is upright, excess sample in trough 608 will flow back into collection cup 604 through the apertures 612 in the base surface 624. Because apertures 612 are formed in the base surface 624 of trough 608, the upper level of sample within base channel 616 will correspond to the upper surface of base surface 624 after excess fluid flows through the apertures 612.

Referring to the cross-sectional side views provided in Figures 9 and 10, trough 608 includes a wall 622, and the ramp portion 626 is flanked by a pair of side walls 628. Accordingly, trough 608 is defined by wall 622, base surface 624, ramp portion 626, and side walls 628. A flow opening 630 remains adjacent to ramp portion 626 in order to permit the flow of sample from within collection cup 604 and trough 608 of docking lid 602 after the sample passes through an interior portion of trough 608. Accordingly, sample can flow through opening 630 and slot 610.

As for the connection between docking lid 602 and collection cup 604, docking lid 602 is provided with a skirt 620 that extends around the perimeter of docking lid 602 (except for the space at flow opening 630 between side walls 628). Skirt 620 of docking lid 602 engages a rim portion 617 of collection cup 604.

The collection device embodiment 600 illustrated in Figs. 8-10 confers several advantages. Collection device 600, for example, permits the use of a standard, low cost collection cup 604 in order to reduce the total cost of the testing system. More specifically, for example, a collection cup such as collection cup 500 illustrated in Fig. 6A may require special tooling. Although the docking lid 602 of collection device 600 would likely be an injection-molded product requiring a specific tool, the per-unit cost of the docking lid 602 should be lower than the per-unit cost of collection cup 500. Also, the collection device 600 can be provided with a variety of docking lid configurations in order to accommodate a variety of

test kit designs. Each of the docking lid configurations can be designed to fit a standard collection cup such as collection cup 604.

Referring now to Figs. 11 and 12, an assembly of a test kit with collection device 600 is illustrated. The test kit, generally designated by the numeral "632", differs from test kit 20 in that it facilitates the exposure of bottom portions of the test strips for wetting in a sample such as a bodily fluid. More specifically, test kit 632 includes a housing 634 and a pair of flaps 636 (only one of the flaps 636 is clearly shown in Fig. 11) that are connected to the housing 634 by means of a flexible hinge 638. When the flaps 636 are separated from one another like a clamshell to the open position shown in Fig. 11, the end portions of test strip 640 extend outwardly below the line of hinge 638. Further details of a test kit similar to test kit 632 are provided in co-pending Application Serial No.

_____, filed on even day herewith ("Device and Method for Drug Test").

Collection device 600 is adapted to receive a portion of test kit 632 for wetting of the test strips 640. More specifically, trough 608 of docking lid 602 accommodates and receives the lower portion of test kit 632 in such a way as to expose the end portions of test strips 640 to a controlled volume of sample.

As is illustrated in Fig. 11, outer perimeter edges of test kit 632 slide within side channels 614 of trough 608, thereby providing for alignment of the test kit 632 with respect to the docking lid 602. It should be noted that the bottom corner surfaces of the test kit 632 (i.e., the surface that is aligned with hinge 638) provide stop surfaces which rests against the lower surfaces of side channels 614, thereby controlling the depth to which test kit 632 is inserted within trough 608.

Referring now to Fig. 12, the end portions of test strips 640 extend downwardly into the interior of base channel 616, which contains the controlled volume of a sample such as bodily fluid. The configuration of the ends of test strips 640 with respect to housing 634 of test kit 632, as well as the relative dimensions of the side channels 614, base surface 624, and base channel 616, provide for the positioning of the lower tips of test strip 640 within base channel 616. Preferably, test strip 640 will not contact the bottom surface of trough 608, but should extend into base channel 616. The flaps 636 of test kit 632, which flaps are preferably

narrower than housing 634, are preferably held in an open position as shown in Fig. 12 by internal surfaces of the trough 608.

Fig. 12 further illustrates the benefits achieved by providing a trough that is configured to receive a portion of a test kit for submersion in a controlled volume of a sample of a bodily fluid. The height and volume of base channel 616 is selected to contain a pre-determined volume of sample. For example, a preferred height for base channel 616 is about 5 mm. The provision of a controlled volume or height of a sample ensures an adequate volume of sample to sufficiently wet the test strips 640. On the other hand, the provision of a controlled volume reduces the chance that the test strips 640 will become flooded with too great a volume of the sample. In other words, the trough according to this invention preferably ensures that the test kit is neither exposed to too much nor too little sample, thereby reducing the chance of test strip "starvation" or flooding". As is illustrated in the various embodiments shown in the drawings, the trough can be a component of the collection cup or the lid of the container.

Although illustrated and described herein with reference to certain specific embodiments, the present invention is nevertheless not intended to be limited to the details shown. Rather, various modifications may be made in the details within the scope and range of equivalents of the claims and without departing from the spirit of the invention. For example, although the test kit 20 is shown as being docked to the collection kit 10 and then the combined collection cup and test are placed into the reader platform 60, it is contemplated that, once the test kit has been wetted and has produced its result, it may be mounted into the reader platform 60 without the collection cup, in a position such that it can be read by the automated reader 55.